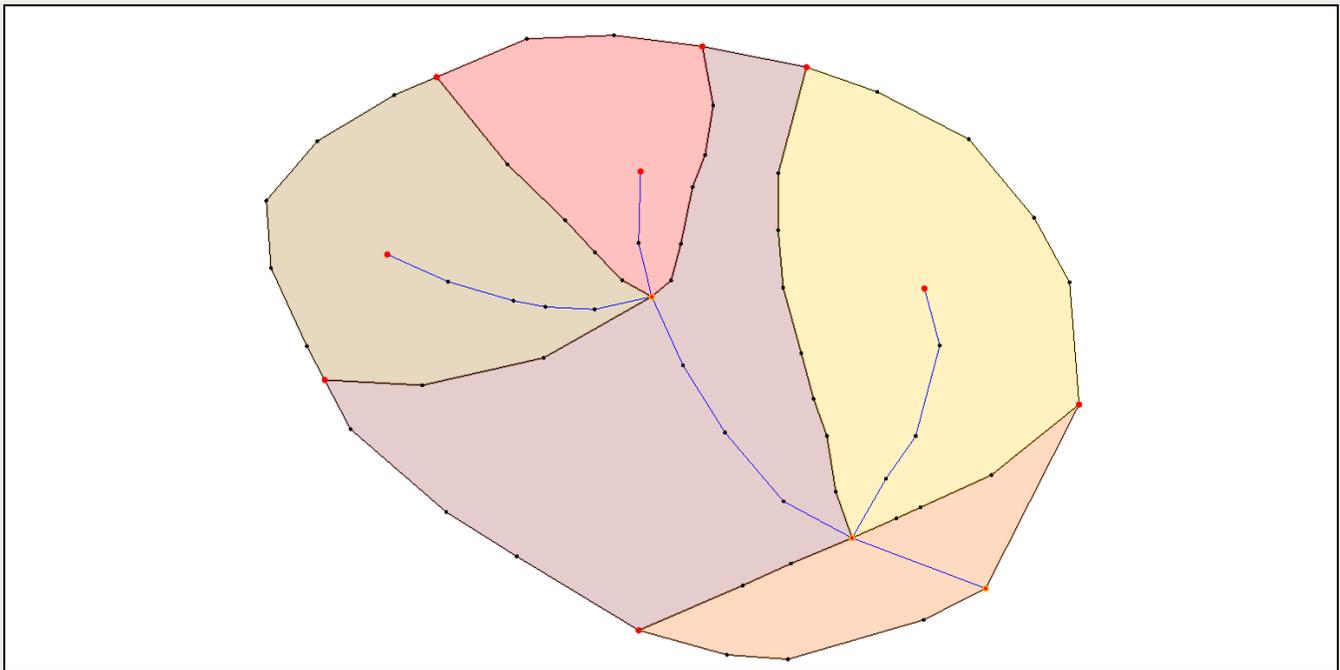*WMS 11.4 Tutorial*

Watershed Modeling – WinTR-20 Interface
Learn how to setup a WinTR-20 model using WMS

Objectives

Build a WinTR-20 model that includes reservoir and stream routing using a map-based watershed model as a starting point.

Prerequisite Tutorials

- Watershed Modeling – Feature Objects

Required Components

- Data
- Drainage
- Map
- Hydrology
- Hydrologic Models

Time

- 15–25 minutes

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1   Introduction

The hydrologic modeling module in WMS contains an interface for TR-20 that can be selected from the model drop-down window. In the TR-20 menu, you can define Information for TR-20, WinTR-20, and WinTR-55 models.

WMS uses the same TR-20 interface for creating TR-20, WinTR-20, and WinTR-55 models. Tools similar to the tools for computing Curve Numbers and Time of Concentration that are included with NRCS's WinTR-55 software are included in WMS. Procedures and tutorials for computing these parameters are included elsewhere in the WMS documentation. Also note that WinTR-55 includes dimensionless unit hydrographs. WMS includes these unit hydrographs in the TR-20 Job Control dialog. Further, note that WinTR-55 includes standard rainfall distributions in the interface. These rainfall distributions can be accessed from the TR-20 precipitation dialog when selecting a custom rainfall distribution. A button to access data from NOAA Atlas 14 is also available in the TR-20 precipitation dialog.

When saving and running TR-20 files, WMS uses the DOS executable distributed as TR-20 from the 1980's-90's and saves files to the ".dat" file format used with that version of TR-20. When saving and running WinTR-20 files, WMS uses the latest DOS executable distributed with WinTR-20 and saves files to the updated ".inp" file format used with this version of TR-20. The DOS executable distributed with WinTR-20 is similar to the executable distributed with WinTR-55 with a few updates. This means you can build a TR-20 model in WMS and run this model in the "old" TR-20 as well as in WinTR-20 (or WinTR-55 since this uses the same DOS executable as WinTR-20).

Note that there are a few differences in data requirements between TR-20 and WinTR-20 files. For example, WinTR-20 channel cross sections require a top width for each cross section elevation as well as an energy grade slope. These parameters are not required when building an old-style TR-20 model but are included in the TR-20 dialogs to allow you to develop WinTR-20 models. Note that there are also some computation differences between the TR-20 and WinTR-20/WinTR-55 models. These computation differences are described in detail in the WinTR-20 documentation.

When developing a WinTR-20 model, geometric attributes such as areas, lengths, and slopes can usually be computed automatically from the digital watershed. Parameters such as curve number, time of concentration, precipitation, and routing data can either be computed using the tools in WMS or entered through a series of interactive dialog boxes.

Once the parameters needed to define a WinTR-20 model have been entered, an input file with the proper format for WinTR-20 can be written and run from the WMS interface. WMS reads the hydrographs and the WinTR-20 model runs results. Since WinTR-20 and WinTR-55 use the same computation engine, the results from running either of these models are identical.

In this tutorial, you will do the following things in WMS:

1. Read an existing watershed schematic.

2. Set the model type to TR-20.

3. Define the following TR-20 model parameters:

    a. Basin data.

    b. Reservoir data.

    c. Reach routing data.

    d. Precipitation and Job Control.

4. Save and run the WinTR-20 input file.

5. Read the solution.

2   Getting Started

Starting WMS new at the beginning of each tutorial is recommended. This resets the data, display options, and other WMS settings to their defaults. To do this:

1. If necessary, launch WMS.

2. If WMS is already running, press *Ctrl-N* or select *File* | **New…** to ensure that the program settings are restored to their default state.

3. A dialog may appear asking to save changes. Click **No** to clear all data.

The Graphics Window of WMS should refresh to show an empty space.

3   Read Existing Watershed Schematic and Set Model Type

First, read an existing watershed schematic for the Sterling Creek watershed:

1. Select *File* | **Open** to bring up the *Open* dialog.

2. Select "WMS XMDF Project File (*.wms)" from the *Files of type* drop-down.

3. Browse to the *WinTr20\WinTr20* folder and select "SterlingCreek.wms".

4. Click **Open** to import the project and exit the *Open* dialog.

5. Switch to the **Hydrologic Modeling Module** .
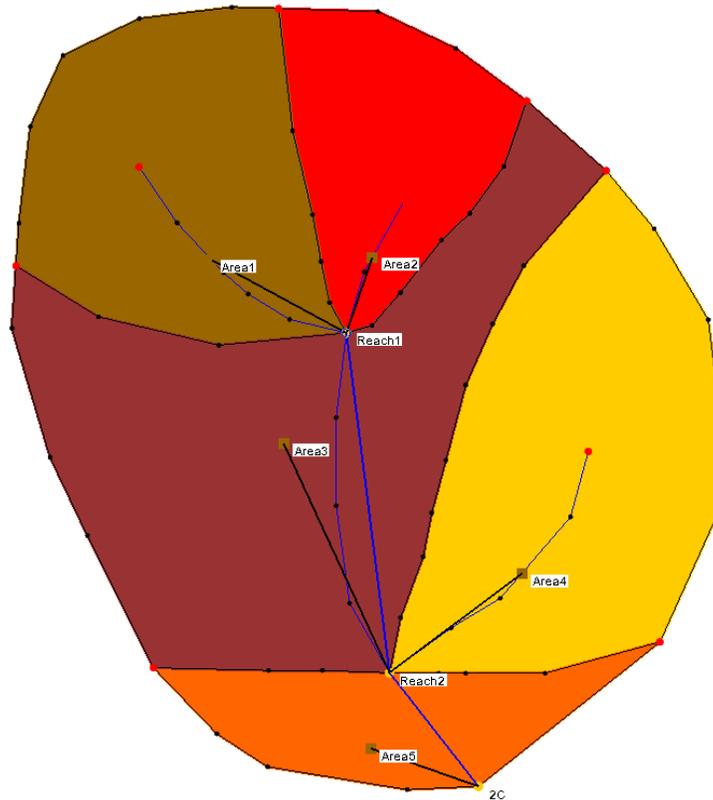
A watershed model should appear (Figure 1).

Figure 1   The watershed model

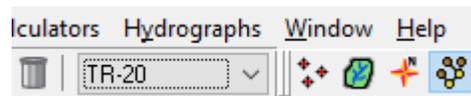6. Select "TR-20" from the Model list drop-down (Figure 2).

Figure 2   Model list drop-down

4   Define Model Parameters

In this section, you define all the necessary model parameters.

4.1   Basin Data

First, define the areas, curve numbers, and time of concentration values for each of the sub-basins in your watershed.

1. Using the **Select basin** tool, double-click in the basin labeled "Area1" to bring up the *Edit TR-20 Parameters* dialog.

2. Select the **Basin Data** button to bring up the *TR-20 Basin Data* dialog.

3. Change the *Area* to "1.6".

4. Change the *SCS curve number* to "80".

5. Change the *Time of concentration* to "1.7".

6.   Select the **OK** button to close the *TR-20 Basin Data* dialog.

7.   Click **Done** to exit the *Edit TR-20 Parameters* dialog.

8.   Follow the above steps to enter the information for each sub-basin as shown below:

Table 4.1. Basin Parameters for the Sterling Creek Watershed.

Name	Area	Curve Number	Time of Concentration
Area1	1.6	80	1.7
Area2	2.0	78	2.6
Area3	1.1	82	1.5
Area4	2.2	72	2.6
Area5	1.2	79	1.3

4.2   Reservoir Data

Define the reservoir data associated with the outlet at **Reach1** as shown below:

1.   Using the **Select outlet** 🔍 tool, select and right-click on the "4C" outlet (Figure 3) and select the *Add | Reservoir* menu item.

2.   Double-click on the "4C" outlet to bring up the *Edit TR-20 Parameters* dialog.
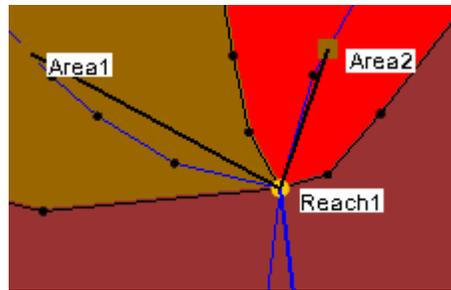

Figure 3   Reach1 outlet

3.   Click **Reservoir Routing** to bring up the *TR-20 Reservoir Routing* dialog.

4.   Turn *Define reservoir routing* on and turn *Define start routing elevation* on.

5.   Enter "128" ft for the *Start routing elevation*.

6.   Select **Define Reservoir Data** to bring up the *TR-20 Reservoir Data* dialog.

7.   In the *TR-20 Reservoir Data* dialog, click **New** and enter "Struct 1" for the *Current Reservoir Data Series* name.

8.   In the table on the right, enter the reservoir information shown in the following table:
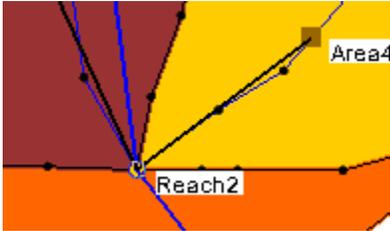
Table 4.2. Reservoir Parameters for the Reach1 Outlet.

Elevation (ft)	Discharge (cfs)	Storage (ac-ft)
128.00	0.00	65.00
128.50	10.00	130.00
131.00	110.00	390.00
132.50	340.00	600.00
135.00	630.00	840.00
137.50	900.00	1100.00

9.   Select **OK** to close the *TR-20 Reservoir Data* dialog.

10. Select **OK** to close the *TR-20 Reservoir Routing* dialog.

11. Select **Done** to close the *Edit TR-20 Parameters* dialog

4.3   Reach Routing Data

Define the reach routing data associated with the outlet at Reach2 as shown below:

1. Using the **Select outlet** ![tool icon] tool, double-click on the "Reach2" outlet (Figure 4) to bring up the *Edit TR-20 Parameters* dialog.
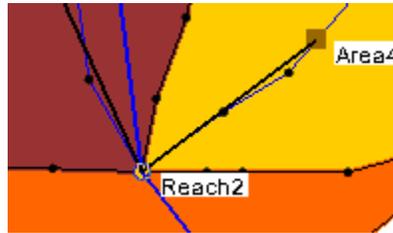

Figure 4   Reach2 outlet

2. Click **Routing Data** to bring up the *TR-20 Routing Data* dialog.

3. Turn *Define reach routing* on.

4. Enter "2500" ft for the *Reach length*.

5. Select the **Define Reach Cross Section** button to bring up the *TR-20 Cross Section Data* dialog.

6. In the *TR-20 Cross Section Data* dialog, click **New**.

7. Turn on *Bank-full elevation* and enter a value of "121.5" ft.

8. Turn on *Low ground elevation* and enter a value of "120.0" ft.

9. Enter an *Energy grade slope* of "0.00080".

10. In the table on the right, enter the cross section information shown in the following table:

Table 4.2. Cross Section Parameters for the Reach2 Outlet.

Elevation (ft)	Discharge (cfs)	End Area (ft^2)	Top Width (ft)
116.50	0.00	0.00	0.00
119.50	75.00	60.00	33.00
120.50	150.00	100.00	42.00
123.50	600.00	370.00	200.00
126.00	1800.00	1200.00	450.00
127.50	3000.00	2100.00	790.00
128.50	4000.00	2730.00	830.00
129.50	5000.00	3600.00	857.00
130.50	6000.00	4600.00	890.00

11. Select **OK** to close the *TR-20 Cross Section Data* dialog.

12. Select **OK** to close the *TR-20 Routing Data* dialog.

13. Select **Done** to close the *Edit TR-20 Parameters* dialog.

4.4   Precipitation

In order to simulate a rainfall event, enter both a rainfall depth and a temporal distribution. The NRCS and other agencies have provided standard time distributions for different areas of the U.S. These are stored in WMS. Additionally, a series can be defined based on an actual storm or on a design from a regulating agency.

1. From the *TR-20* menu, select **Job Control** to open the *TR-20 Job Control* dialog.

2. For *Title Record 1*, enter "Sterling Creek Watershed".

3. For *Title Record 2*, enter "Custom Rainfall Table".

4. Select **Define Precipitation** to open the *TR-20 Precipitation* dialog.

5. Under the *Precipitation distribution* drop-down, select "Define custom rainfall distribution".

6. Select the **Define Custom Rainfall Distribution** button to open the *XY Series Editor*.

7. On the lower right, in the *Selected Curve* drop-down, select "typeIII-24hour".

8. Click **OK** to close the *XY Series Editor*.

9. Turn on *Define rainfall depth (inches)* and enter "8.40" inches for the rainfall depth.

10. Click **OK** to close the *TR-20 Precipitation* dialog.

11. Click **OK** to close the *TR-20 Job Control* dialog.

5   Save and Run WinTR-20

Whenever running a WinTR-20 simulation, WMS will first save a WinTR-20 input (.inp) file. All the WinTR-20 output files use the same file prefix as the WinTR-20 input file. Note that you should also be able to run WinTR-20 simulations using the TR-20 executable from the 1990's. The WinTR-20 and the TR-20 options for saving and running are both found in the TR-20 menu.

1. Select *TR-20 | **Run WinTR-20 Simulation…*** to bring up the *Select WinTR-20 Input File Name* dialog.

2. Enter "SterlingCr.inp" as the *File name* and click **Save** to save the file and run WinTR-20.

3. The *Model Wrapper* dialog should appear and WinTR-20 will run (see   Figure 5). After WinTR-20 is finished, click the **Close** button to import the solution and close the *Model Wrapper* dialog.
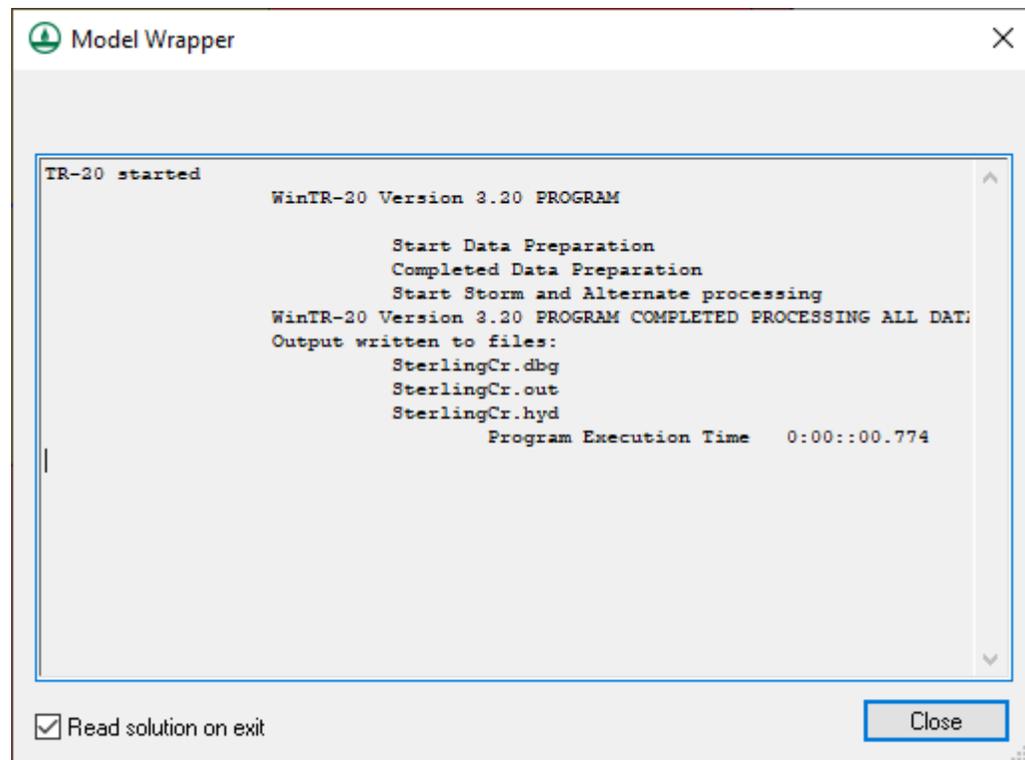
Figure 5   The Model Wrapper dialog for WinTR-20 after a successful run

6   Reading the Solution and Reviewing Output

After running WinTR-20, a small hydrograph plot icon will appear next to each of the basins and outlets in the model.

1.   Using the **Select hydrograph** tool and holding down the **Shift** key, click on several of the hydrograph icons,

2.   Select *Display |* **Open Hydrograph Plot** to open the *Hydrograph* dialog.

The dialog should display a hydrograph similar to Figure 6. Notice that the hydrograph continues on for a long time, making it difficult to view the shapes and peak flows of the individual hydrographs.
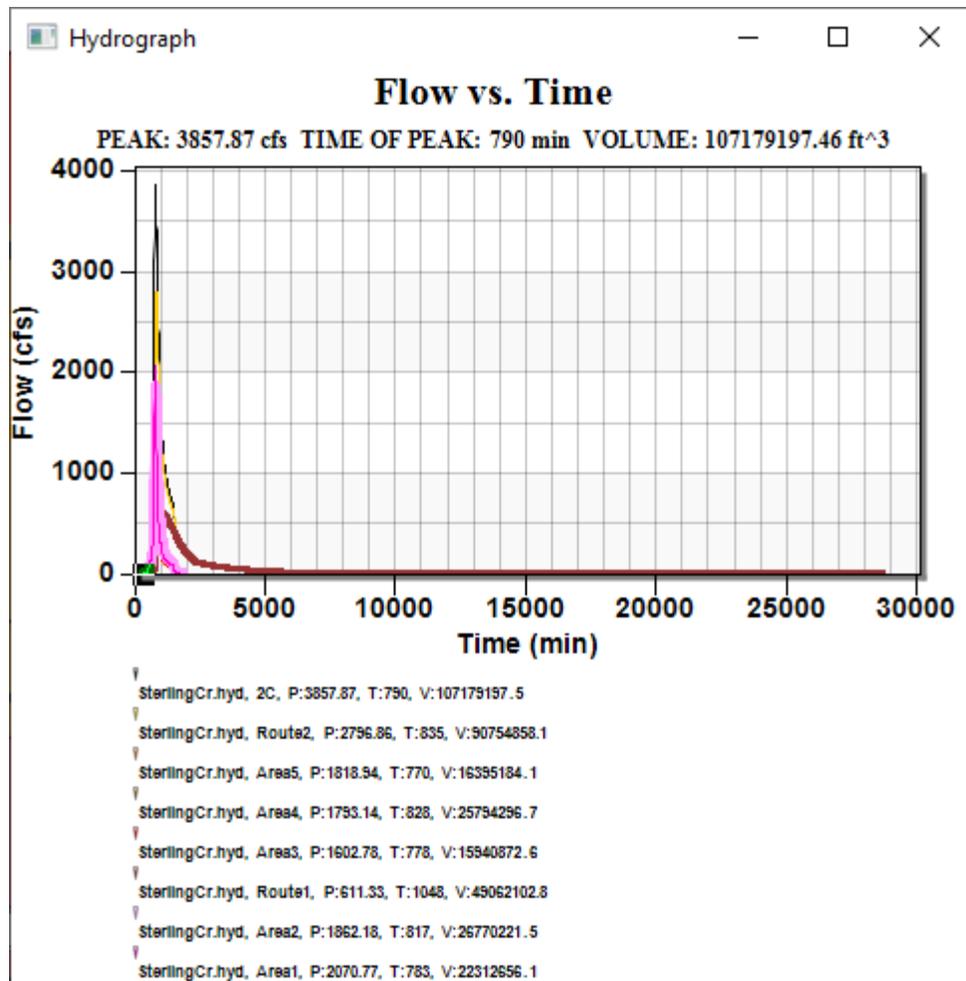
Figure 6   Hydrograph after WinTR-20 run

3. If desired, resize the window to make it larger and left-click and drag in the hydrograph plot to zoom into the portion of the hydrograph where the peak flows occur as shown in   Figure 7.
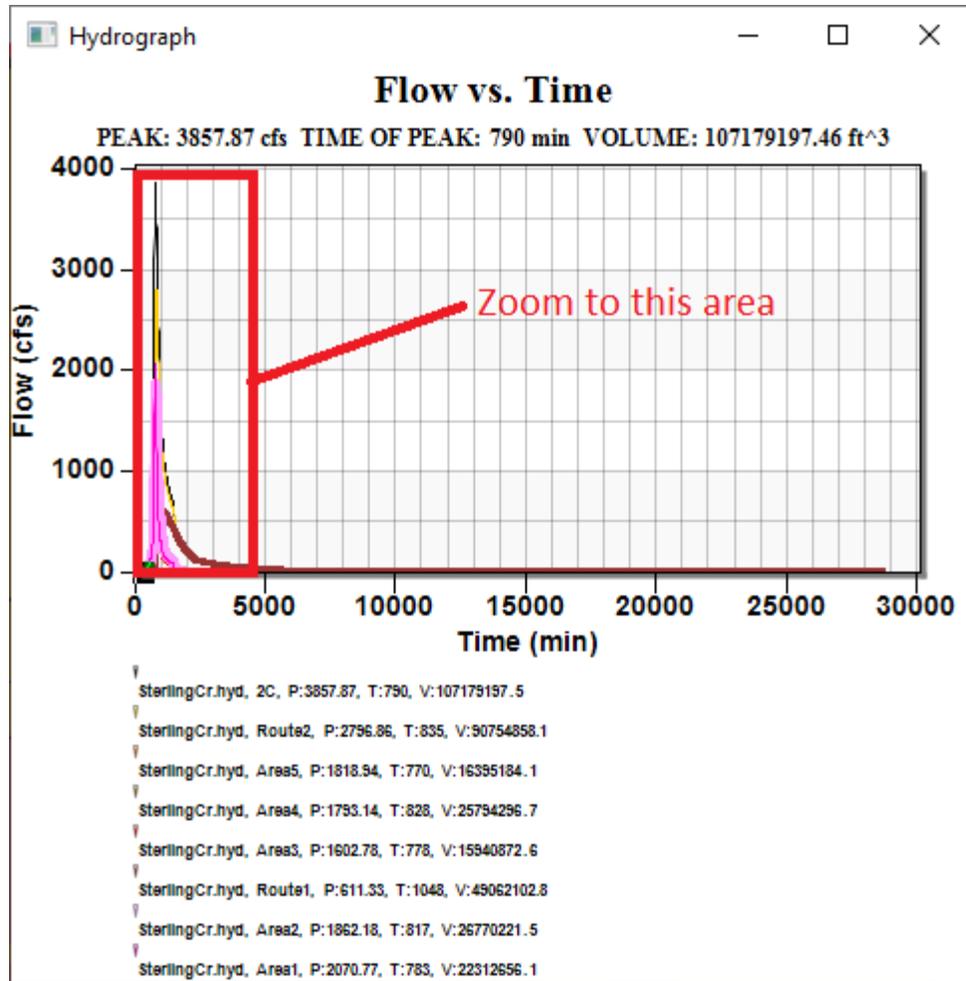
Figure 7   Zooming to the hydrograph

4. Your hydrograph should look something like the plot shown in   Figure 8.
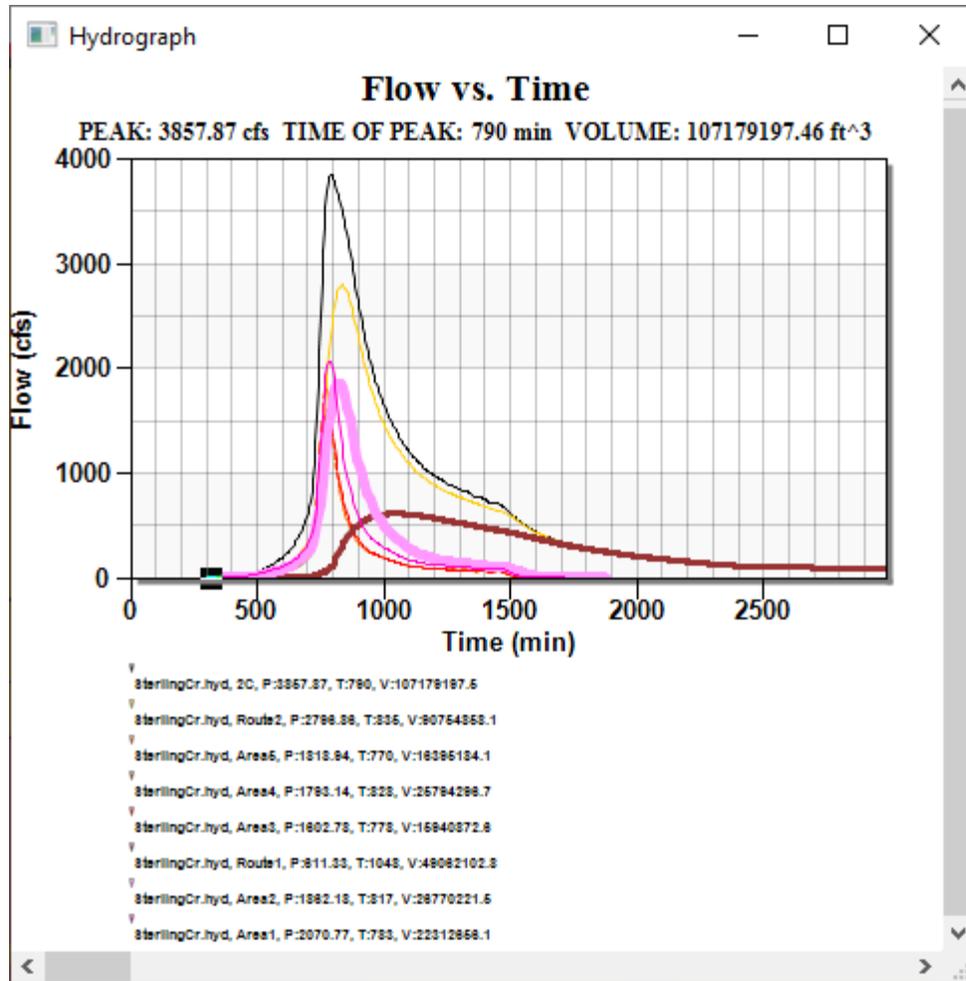
Figure 8   Zoomed into the hydrograph plots

5. Close the *Hydrograph* dialog.

While WMS makes it easy to set up a WinTR-20 model and compute a result, it is not a substitute for understanding the basic theory and equations used in WinTR-20. For further detail and information, consult texts on hydrologic modeling and read the WinTR-20 manual.

6. Notice the solution files that were read with the solution in the Project Explorer (see   Figure 9). If desired, double-click or right-click on some of these files to view them in a text editor. The WinTR-20 output files include the following items:

    a. An output file (.out) that lists all the input and output from the WinTR-20 simulation.

    b. A hydrograph file that contains the hydrographs for each of the sub-basins, reaches, and the outlet for the WinTR-20 model.

    c. An error file that shows any errors associated with running the model (.err).

    d. A debug file (.dbg).

If there are any problems running the simulation, the error file contains details about the problems and how to fix them. Fix these errors, then save and run the WinTR-20 model again. The debug file contains any messages or warnings generated by the WinTR-20 run.
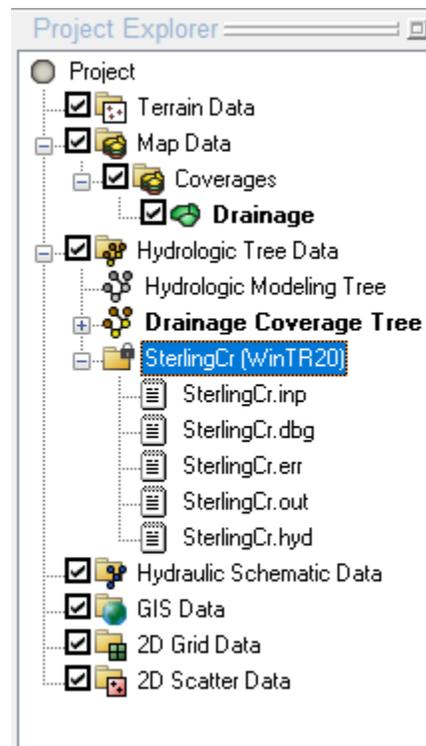
Figure 9   The WinTR-20 solution files

7   Conclusion

This concludes the "Watershed Modeling – WinTR-20 Interface" tutorial. The key concepts discussed and demonstrated include the following:

- Reading an existing watershed schematic.
- Defining basin parameters.
- Defining reservoir and routing parameters.
- Defining precipitation.
- Saving and running WinTR-20 input files.
- Reading and viewing solution results.